Genetically Modified (Transgenic) Plants in Perspective

Santiago, November 7, 2003

Daily Mail

WEDNESDAY, SEPTEMBER 3, 2003

NEWSPAPER OF THE YEAR

40p

THE CANCER OF COCAINE

Special Mail investigation shows how every part of our culture is now tainted by cocaine

Pages 24-25

Ruling by EU bureaucrats could open the floodgates to Frankenstein foods

BRITAIN IS TOLD: YOU CAN'T BAN GM CROPS

BRITAIN was left powerless to stop Frankenstein crops last night following an explosive Brussels ruling.

In a landmark decision, the European Commission said governments which tried to ban genetically-modified crops would be in breach of EU law.

By **Graeme Wilson** and **Michael Taggart**

It means biotech firms could grow GM crops anywhere in Europe in defiance of public opposition and the threat to organic farming.

There were immediate fears that Tony Blair will use the ruling to open the floodgates for GM crops to be grown commercially in Britain.

The Premier has made no secret of his support for the biotech industry, along with science minister Lord Sainsbury, while his new communications director Dave Hill was an adviser for GM giant Monsanto.

Former environment minister

Turn to Page 2, Col. 3

Helen the Calendar Girl, stunning at 58

SEE PAGES 6 & 7

Paradox: Recombinant Food Additives and Drugs Have a Long History of Acceptance (Even in Europe)

Chymosin
(approved in 1990)

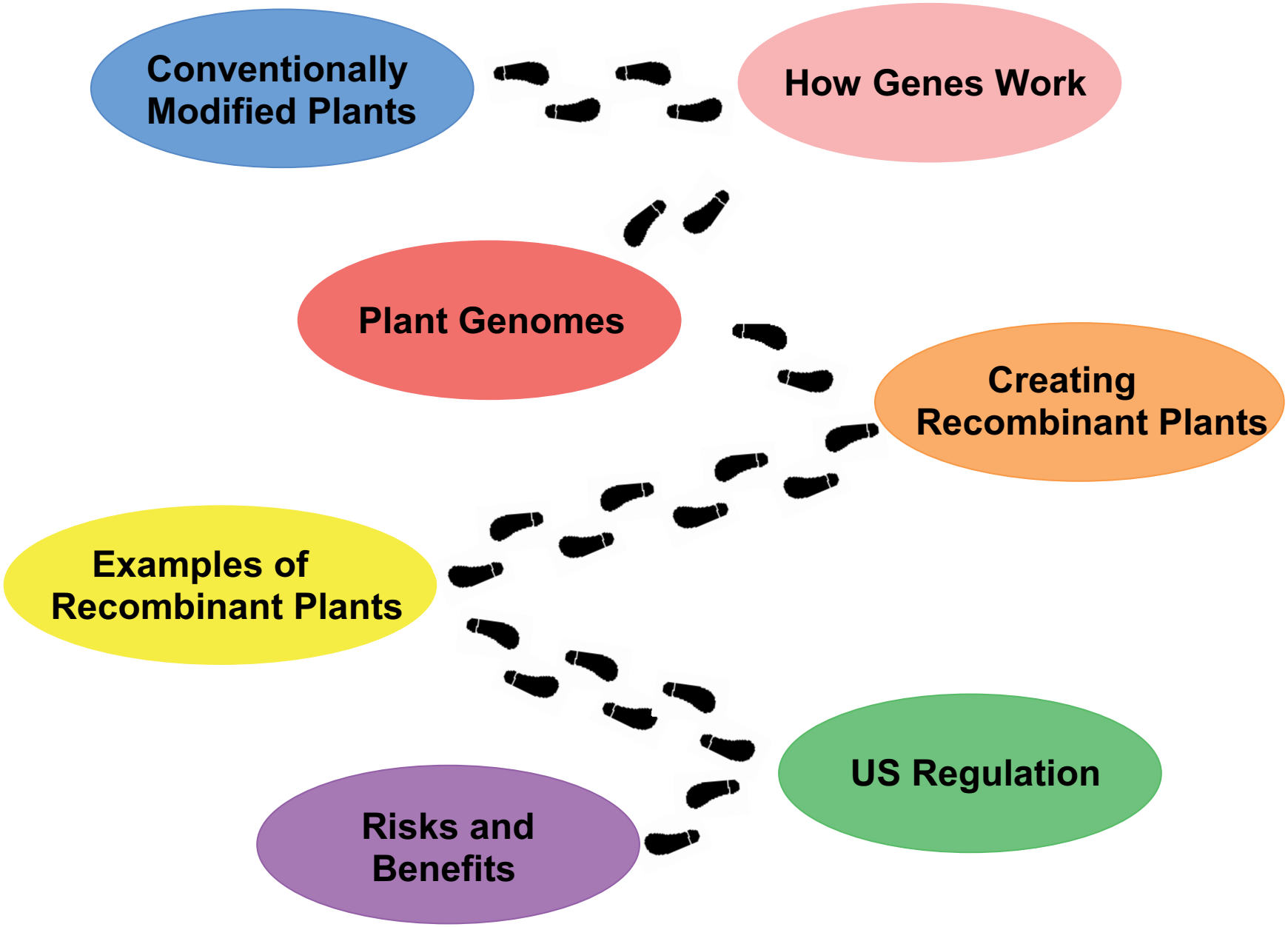
- Historically, **rennin** extracted from calves' stomachs has been used to coagulate milk in cheese making.
- **Chymosin** is one of the important enzymes in **renin**.
- **Recombinant chymosin** is now used to make over 95% of the hard cheese made in the U.S.

Therapeutic Recombinant Proteins

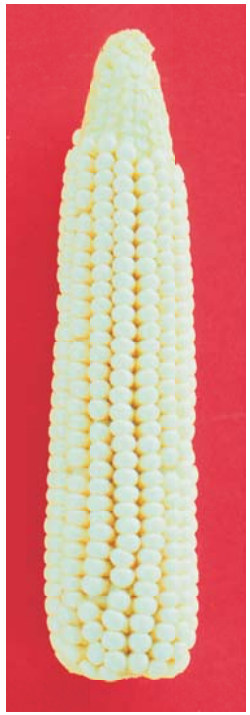
54 products have been approved for marketing in the U.S. since 1982

Coagulation Factors
Fertility Hormones
Glucagon
Growth Factors
Insulin
Interferons
Interleukin
Replacement Enzymes
Tissue Plasminogen Activator

Where I'm going



Zea mays



Brassica oleracea

brussel sprouts

cabbage

wild cabbage

kale

cauliflower

broccoli

kohlrabi

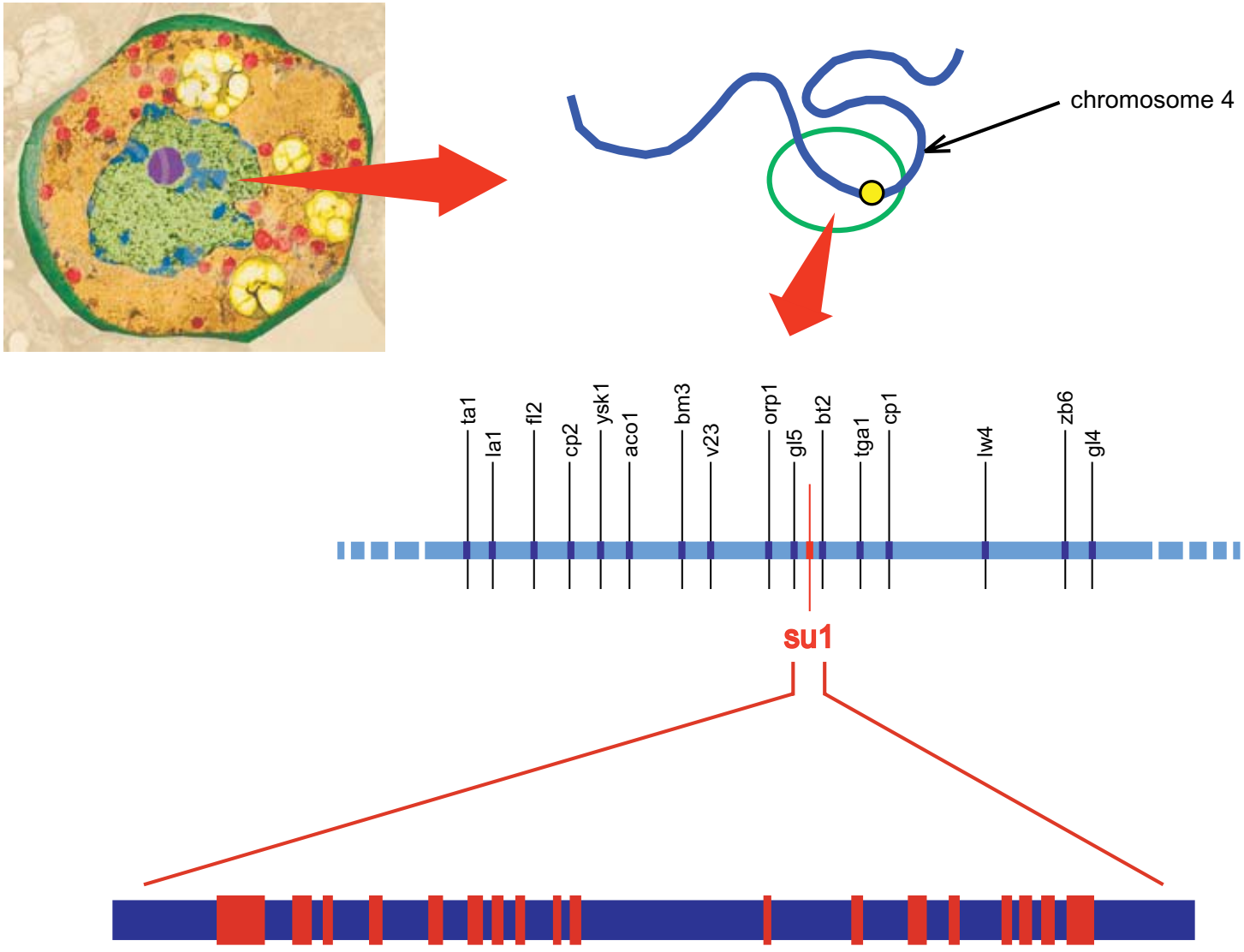
Daucus carrota

The Green Revolution

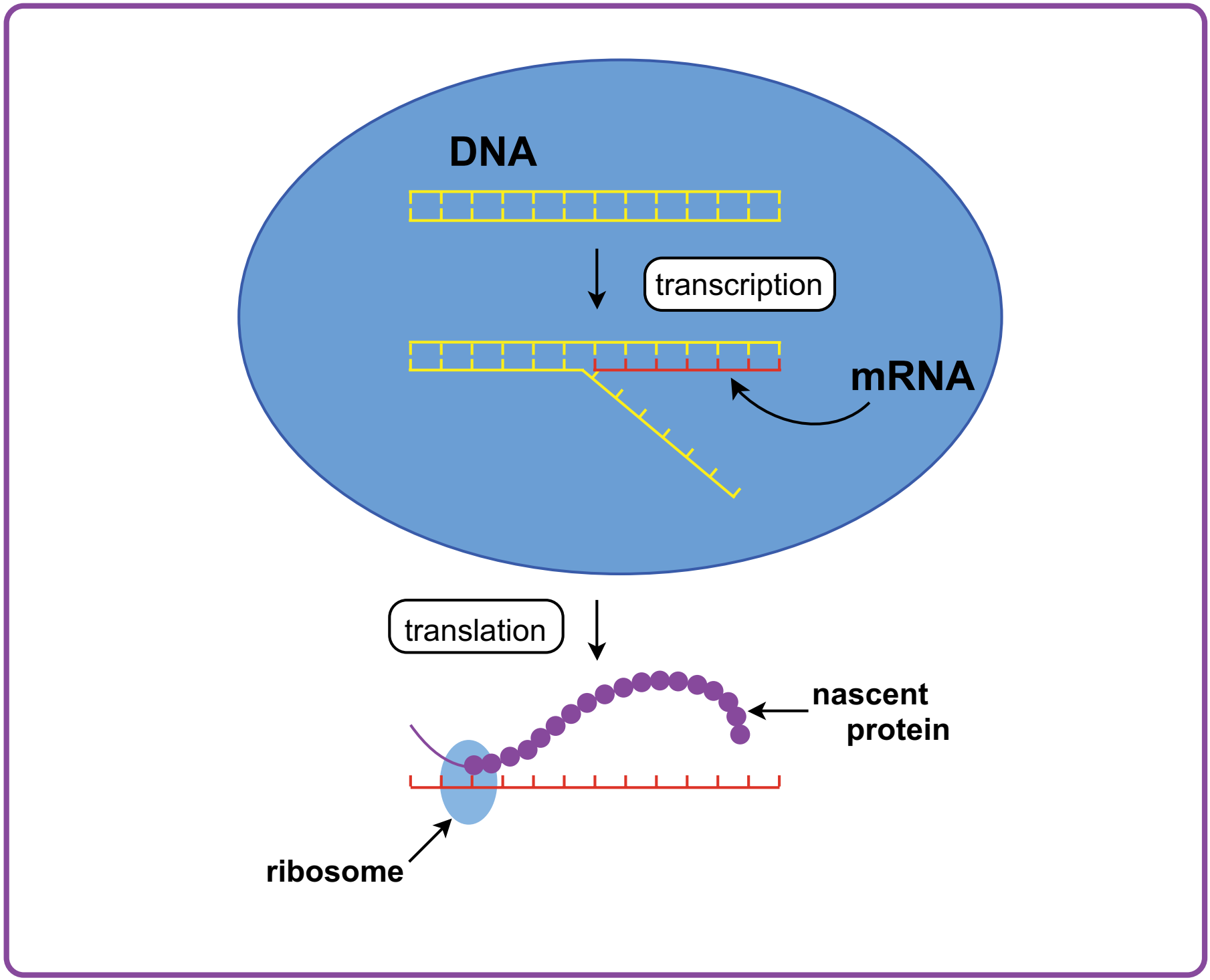
- Semi-dwarf gene - reduced stature (rice, wheat, maize, sorghum)
- Higher yielding
- Changed agricultural practices

sugary1: simple gene inheritance in corn

Quantitative Variation in Tomato Size and Shape



su1 (sugary 1) gene

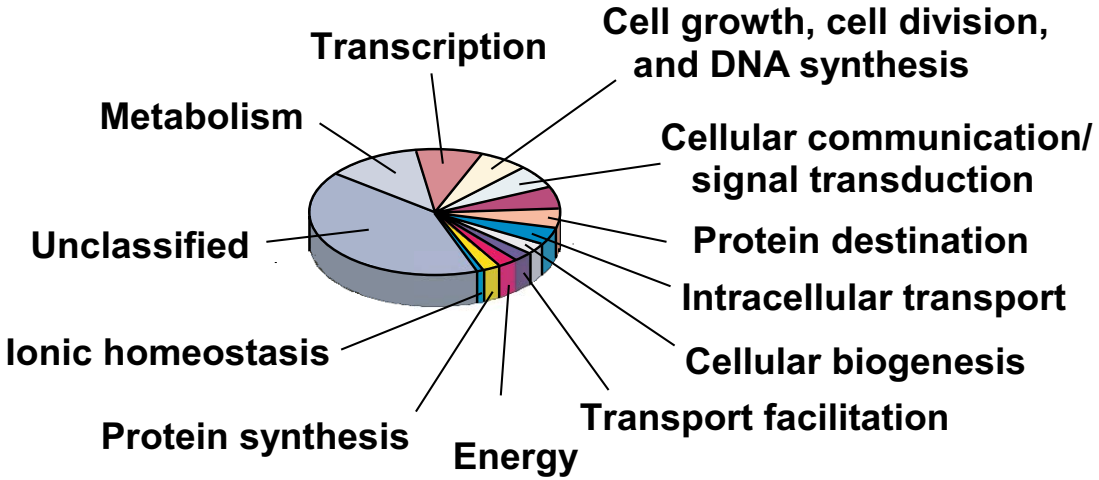

DNA
transcription
mRNA
translation
nascent protein
ribosome

Arabidopsis thaliana
(mouseear cress)

- 26,000 genes
- Differences compared with animals:
  - metabolism
  - cell wall
  - signal transmission
- Gene Duplication
- Wealth of data speeded and changed research

Oryza sativa (rice)

- 42,400 genes
- Monocot-specific genes
- Extensive gene duplication
- Colinearity with other cereals
- Direct application to plant improvement



Sequence homology indicates common function

```
Plant    MDDDIAALVVDNGSGMCKAGFAGDDAPRAVFPSIVGRPRHQGVM
Human    MADGEDIQPLVCDNGTGMVKAGFAGDDAPRAVFPSIVGRPRHTGVM
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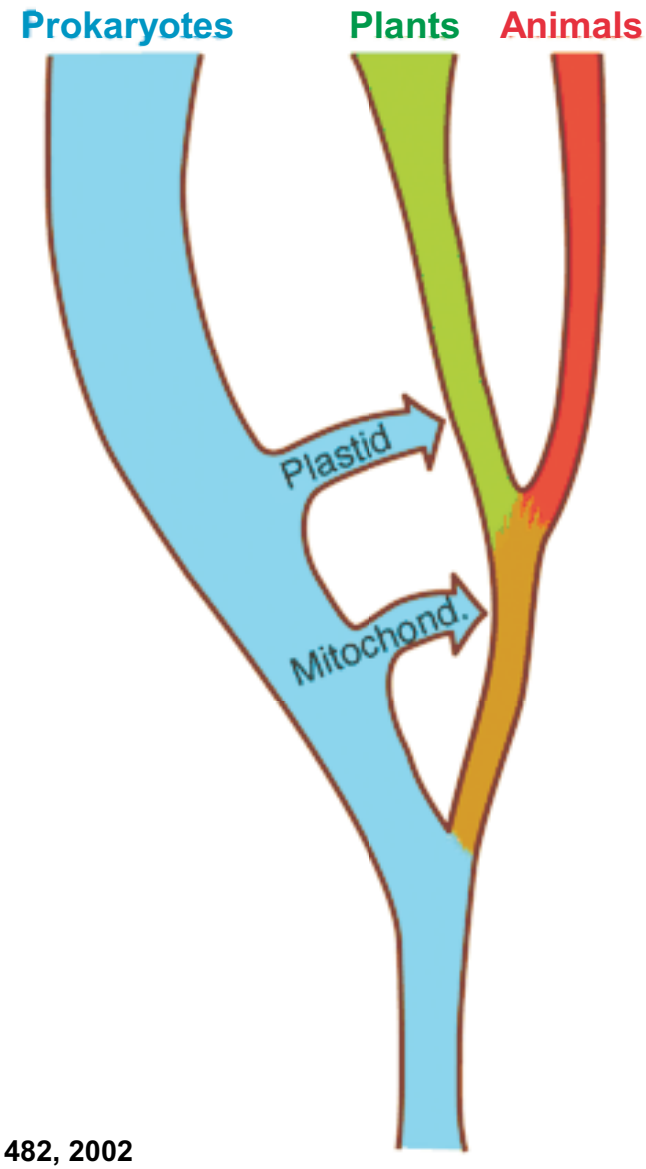
Many genes came from lateral transfer



— Present

— 0.6 Ga Multicellular eukaryotic fossils

— ~1.6 Ga Plant-animal common ancestor

— 2.7 Ga Eukaryotic trace fossils

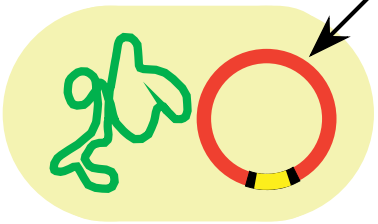
— ~3.8 Ga Evidence for life

Meyerowitz, SCIENCE 295: 1482, 2002

Plant Transformation with *Agrobacterium*

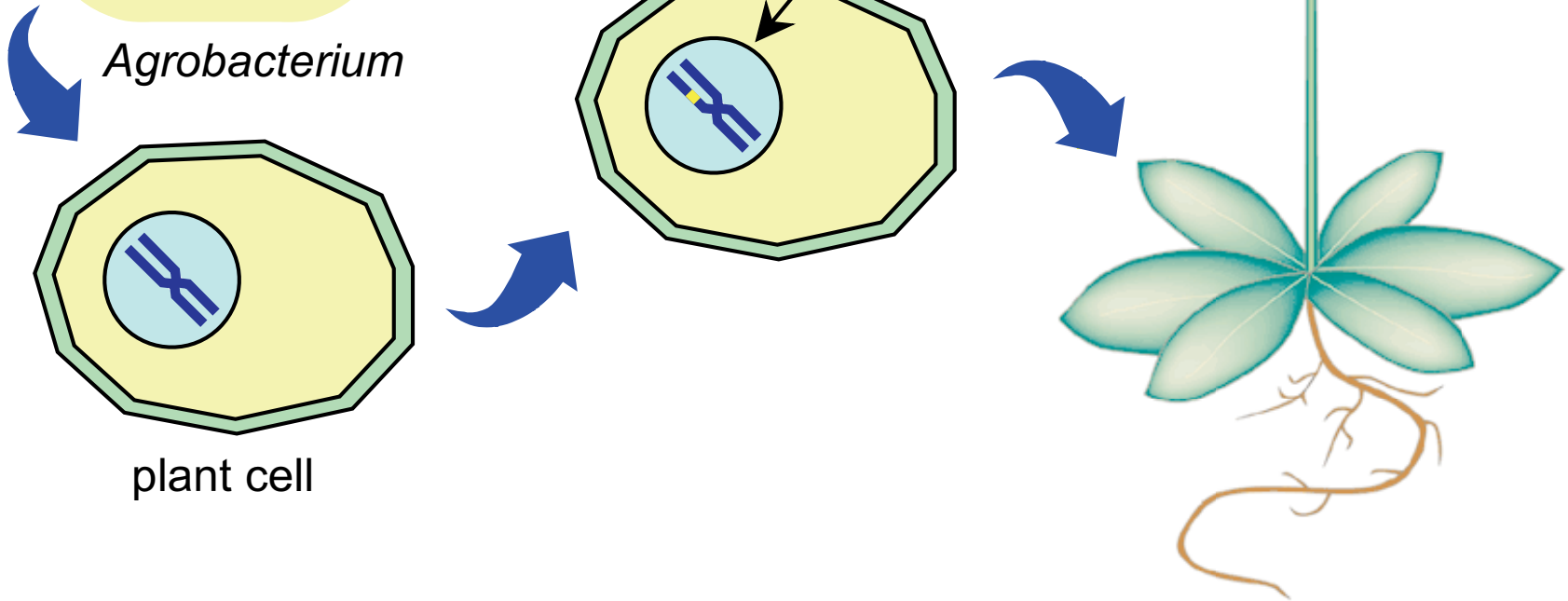
crown gall

recombinant plasmid



Agrobacterium

plant chromosome carrying new gene

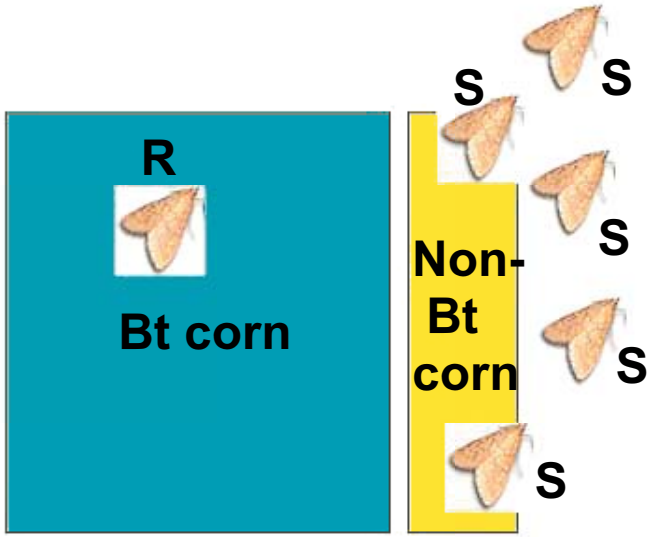


plant cell

Bacillus thuringensis Toxin (Bt)

- Bacteria produce toxins with a variety of specificities
- Not toxic to non-target organisms
- One of the major groups of transgenes

The Refuge Strategy Prevents Evolution of Resistance to Bt Toxin



- EPA mandates 20% non-Bt crop area
- High dose of toxin kills non-resistant insects
- Refuge supplies non-resistant insects that will swamp out resistant mutants that may appear.

Herbicide-resistant Soybeans

Papaya Ringspot Virus

infected immature fruit

electron micrograph
of virus

susceptible
trees

Trees expressing a portion of the virus coat protein are protected from the virus.

Golden Rice

- Worldwide 125 million children suffer from vitamin A deficiency.
- *Beta*-carotene is the precursor to vitamin A.
- Rice has been engineered to produced *beta*-carotene in the seed.

Moonvista

Moonshade

Moonlite

Moonaqua

U.S. Regulation of Recombinant Plants

Public Researcher

Institutional Biosafety Committee

NIH Recombinant DNA Guidelines

Industrial Scientist

USDA [Plant Introduction]

EPA [Environmental Issues]

FDA [Food Safety]

GM Foods Approved for Human Consumption in the US (April, 2002)

Modification	Insect Resistance	Viral Resistance	Herbicide Tolerance	Modified Oil	Plant Sterility	Delayed Ripening/ Softening
GM Plant (# of plant varieties)	Corn (8) Tomato (1) Potato (4) Cotton (2)	Squash (2) Papaya (1) Potato (2)	Canola (8) Corn (9) Cotton (4) Flax (1) Radish (1) Rice (1) Soybean (2) Sugar Beet (2)	Canola (1) Soybean (1)	Canola (3) Corn (3) Radish (1)	Cantaloupe (1) Tomato (4)
Totals	15	5	28	2	7	5

National Research Council, U.S. National Academy of Sciences

"Introduction of Recombinant DNA-Engineered Organisms into the Environment", 1987

- **There is no evidence that unique hazards exist.**
- **The risks are the same as those associated with the introduction of unmodified organisms.**

"Genetically Modified Pest-Protected Plants: Science and Regulation", 2000

- **The committee is not aware of any evidence that foods on the market are unsafe to eat as a result of genetic modification.**

"Environmental Effects of Transgenic Plants: The Scope and Adequacy of Regulation", 2003

- **There are no new categories of risk associated with transgenic plants.**

Genetically Modified Plants

1 What are the risks?

- Food safety
  - Allergens
  - Toxins and anti-nutrients
- Environment
  - Non-target species
  - Weeds

Allergenic Foods

Common Allergenic Foods

Crustacea (e.g. shrimp, lobster)
Eggs
Fish
Milk
Peanuts
Soybeans
Tree Nuts
Wheat

Less Common Allergenic Foods

Fruits

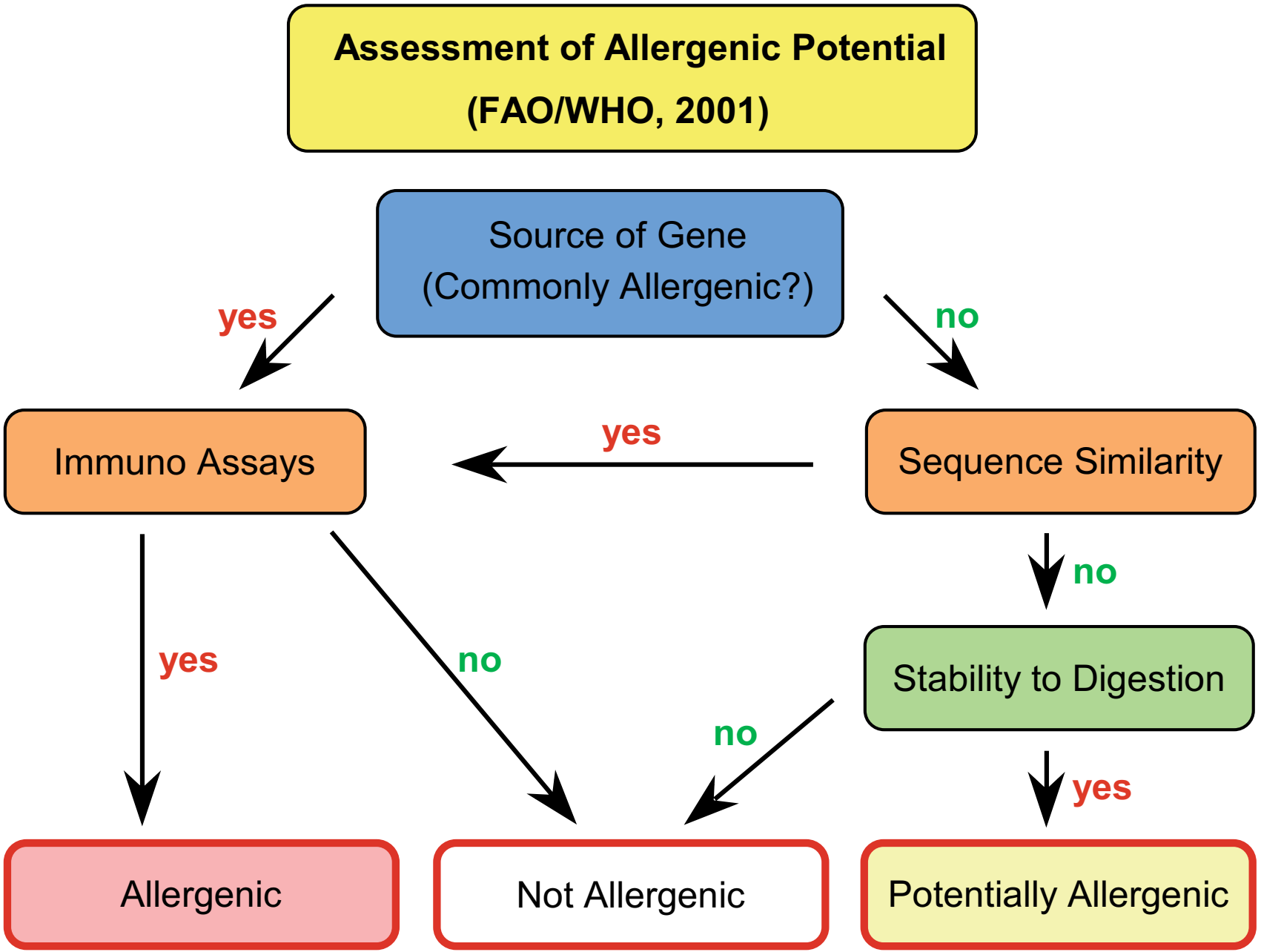
Apple
Avocado
Banana
Cherry
Coconut
Grapes
Guava
Kiwi
Lemon
Mango
Melons
Orange
Peach
Pear
Pineapple
Plum
Strawberry
Tangerine

Vegetables

Barley
Beans
Broccoli
Buckwheat
Cabbage
Carrot
Celery
Corn
Cottonseed oil
Cucumber
Eggplant
Hops
Lettuce
Lentils
Lupine
Millet
Mushrooms
Oats
Parsley
Pea
Pepper
Potato
Rice
Rye
Sesame
Squash
Sunflower
Swiss chard
Tomato
Zucchini

Spices

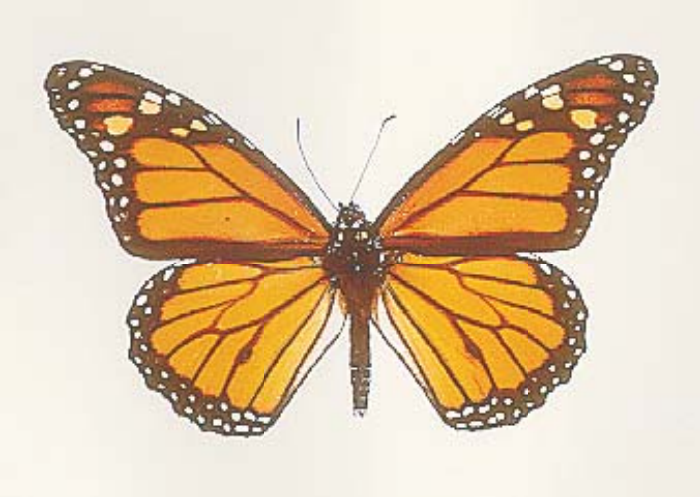
Anise
Chocolate
Cinnamon
Clove
Coriander
Cumin
Curry
Dill
Fennel
Flax seed
Garlic
Ginger
Honey
Maple syrup
Pepper
Mustard
Poppy seed


Assessment of Allergenic Potential
(FAO/WHO, 2001)
Source of Gene
(Commonly Allergenic?)
yes
no
Immuno Assays
yes
Sequence Similarity
yes
no
no
Stability to Digestion
yes
no
yes
Allergenic
Not Allergenic
Potentially Allergenic

Some Common Plant Toxins

present at low levels in many foods

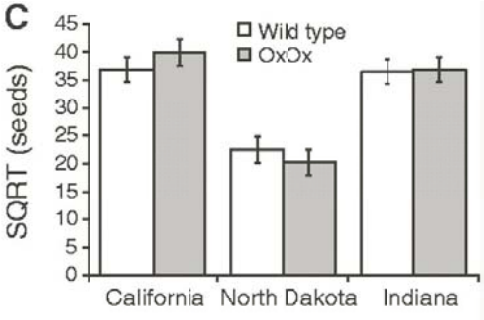
Toxin	Plants	Effects
Cyanogenic glycosides	Sweet potatoes, cassava, stone fruits, lima beans	Gastrointestinal inflammation, inhibition of cellular respiration
Glulcosinolates	Canola, mustard, radish, cabbage, peanut soybean, onion	Goiter, impaired metabolism, decreased protein digestion
Glycoalkaloids	Potato, tomato	Depressed central nervous system, kidney inflammation, carcinogenic, birth defects, reduced iron uptake
Gossypol	Cottonseed	Reduced iron uptake, spermicidal, carcinogenic
Lectins	Most cereals, soybeans, other beans, potatoes	Intestinal inflammation, decreased nutrient uptake
Oxalate	Spinach, rhubarb, tomato	Reduced solubility of calcium, iron, and zinc
Phenol	Most fruits and vegetables, cereals, soybean, potato, tea, coffee	Thiamine destruction, increases cholesterol, estrogen-mimic
Coumarins	Celery, parsley, parsnips, figs	Light-activated carcinogens, skin irritation



The Monarch Butterfly Study

- A widely publicized study claimed that pollen from Bt corn killed Monarch larvae.
- 6 subsequent studies have shown that there is no danger to the Monarch population from transgenic corn.

Sunflower with white rot disease



Fitness of Transgene in Wild Sunflowers

- Transgenic sunflowers containing a gene for oxalic acid synthesis are protected from white rot.
- The same gene, when transfered to wild sunflowers, confers no advantage despite strong selective pressure.

Genetically Modified Plants

2 What are the benefits?

- Economic benefits
- Reduced chemicals
  & other environmental benefits
- Food security and health

Genetically Modified Plants

3 Summary

- An extension of plant breeding
  - New traits
  - One well-characterized gene vs. a large number of unknown genes
- Nature has no boundaries
- Enormous potential benefits
- Risks recognized
  - No new categories of risk

References: http://demeter.bio.bnl.gov/websites.html